AT4-CS Final Update

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110511.WCM 2

Project goal is to demonstrate viability of ALE3D for simulating AT4-CS performance

- Primary deliverables are comparisons of experimental and simulated propellant chamber pressure and projectile exit velocity

- Experimental design went through various iterations
  – finalized geometry for simulation during mid-April LLNL onsite visit at Benét

- 2D simulation constructed from 3D CAD model and updated data

- JWL igniter/propellant equations-of-state constructed

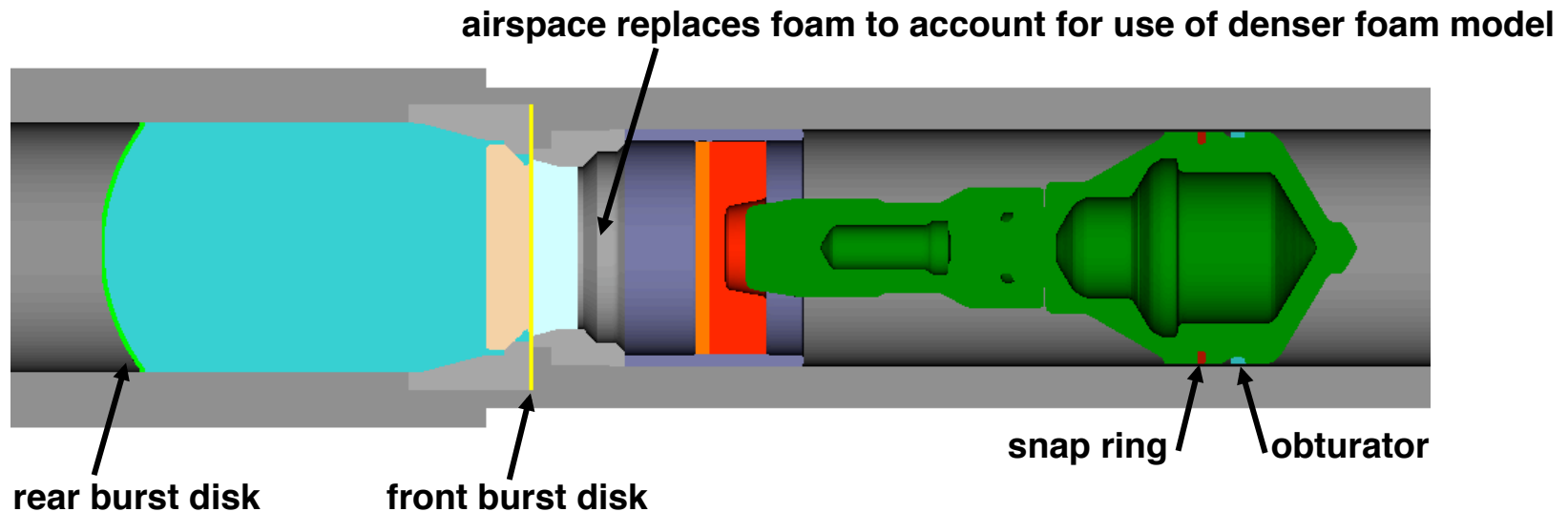- Shakedown calculations performed

Full-view of 2D simulation geometry

- **Simulation details (40K zones, 32 cpu, 4000 s → simulate to 4 ms**
  - **projectile: 1.96 kg ; contains hollow regions**
  - **countermass: 0.9 kg**
  - **cardboard propellant chamber**
  - **Red Dot igniter: 20 gm, 0.875 g/cc**
  - **M38 propellant: 87 gm, 1.096 g/cc**
  - **all non-solid regions filled with air**
  - **slideline along entire length of tube interior including nozzle**
  - **5 pressure gages**

gage 5   gage 4   gage 3   gage 2   gage 1
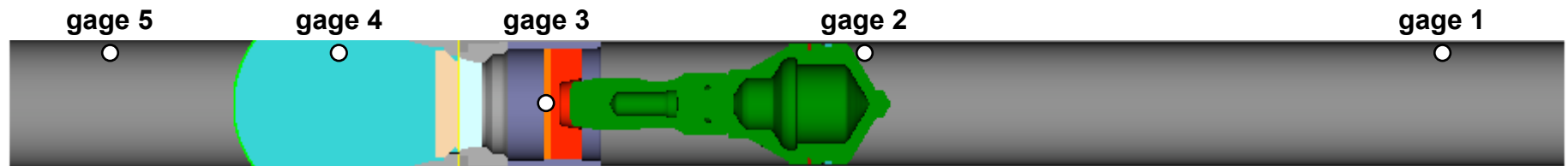
Expanded view of 2D simulation geometry

- **Simulation details**
  - **EPDM: 0.09 g/cc**
  - **LD45: 0.038 g/cc simulated using 0.09 g/cc foam in less volume, to preserve mass**
  - **snap ring and burst disk failure criteria based on time not pressure**
    - **snap ring @ 750μs**
    - **first burst disk @ 600μs**
    - **rear burst disk @ 750μs**

airspace replaces foam to account for use of denser foam model

snap ring   obturator

rear burst disk   front burst disk

Propellant chamber [deliverable 1 of 2] [gage 3] experiment and simulation

- **Simulation "spikes" before 2 ms are due to shock reflections resulting from propellant burn model**
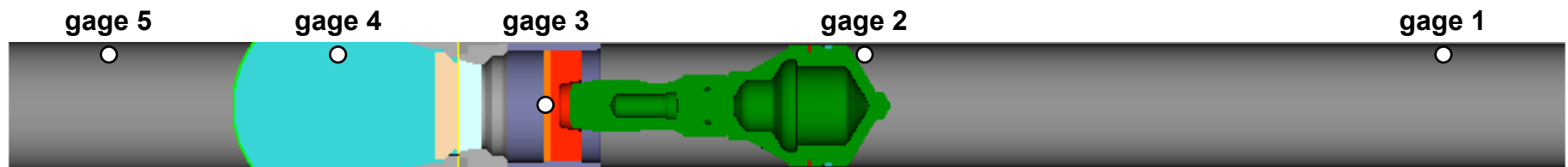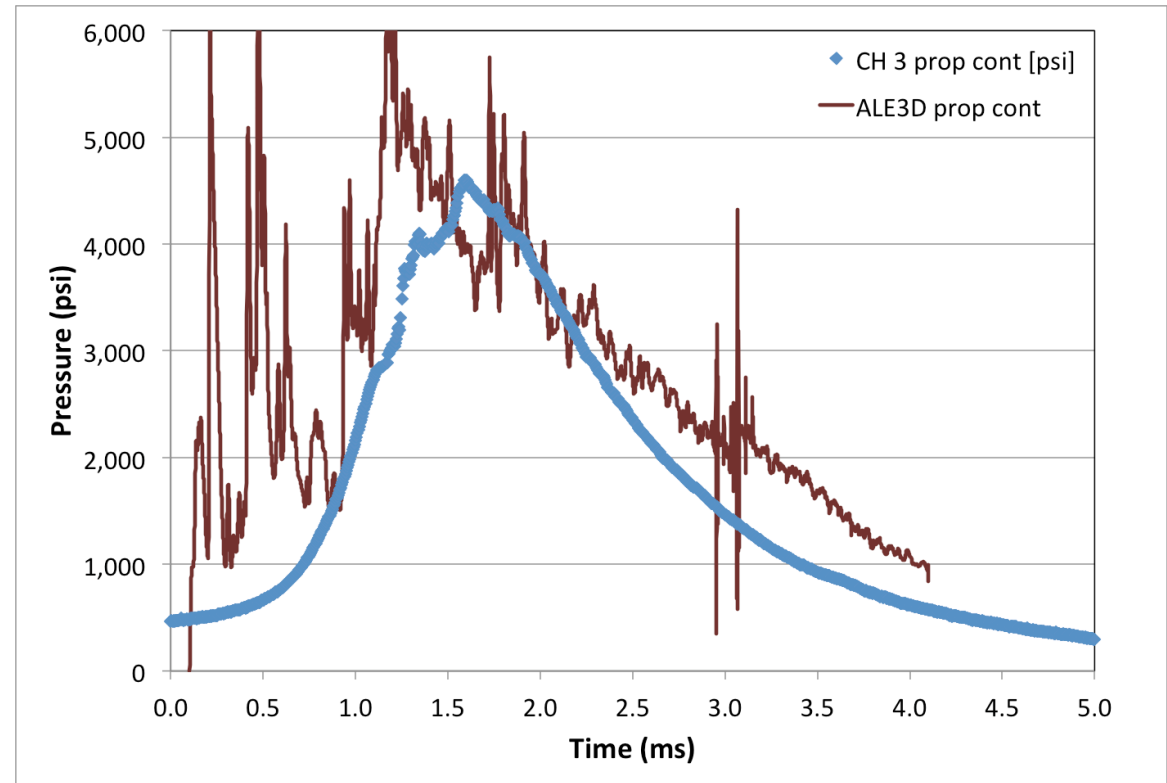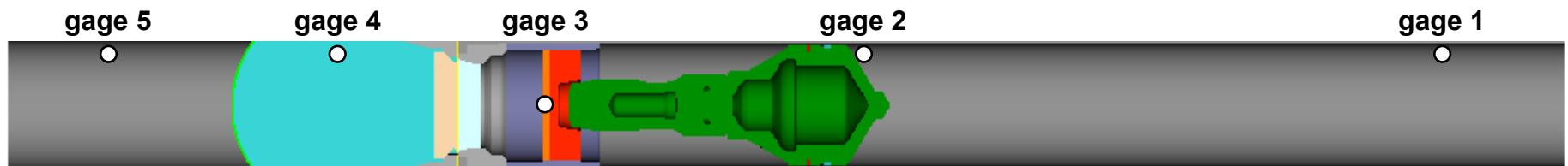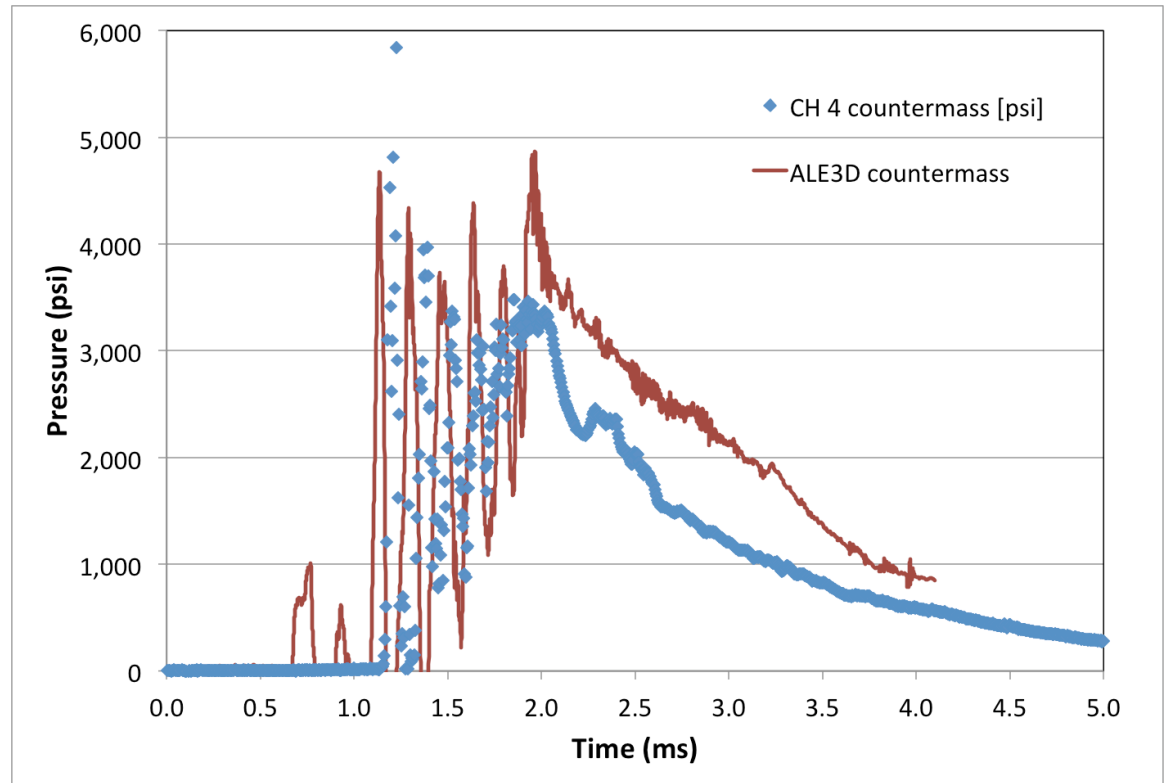
Countermass
[gage 4] experiment and simulation

- **Simulation pulsewidth and structure compare favorably with experimental data**
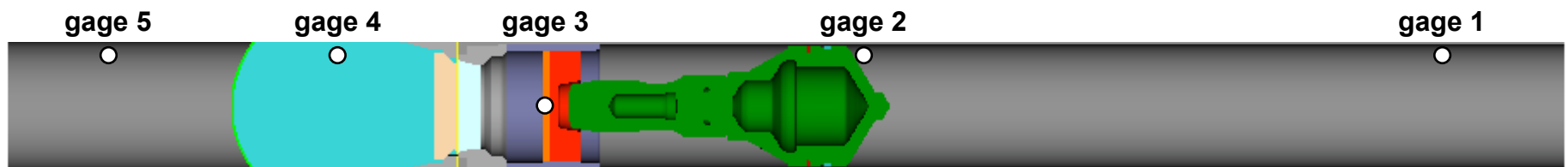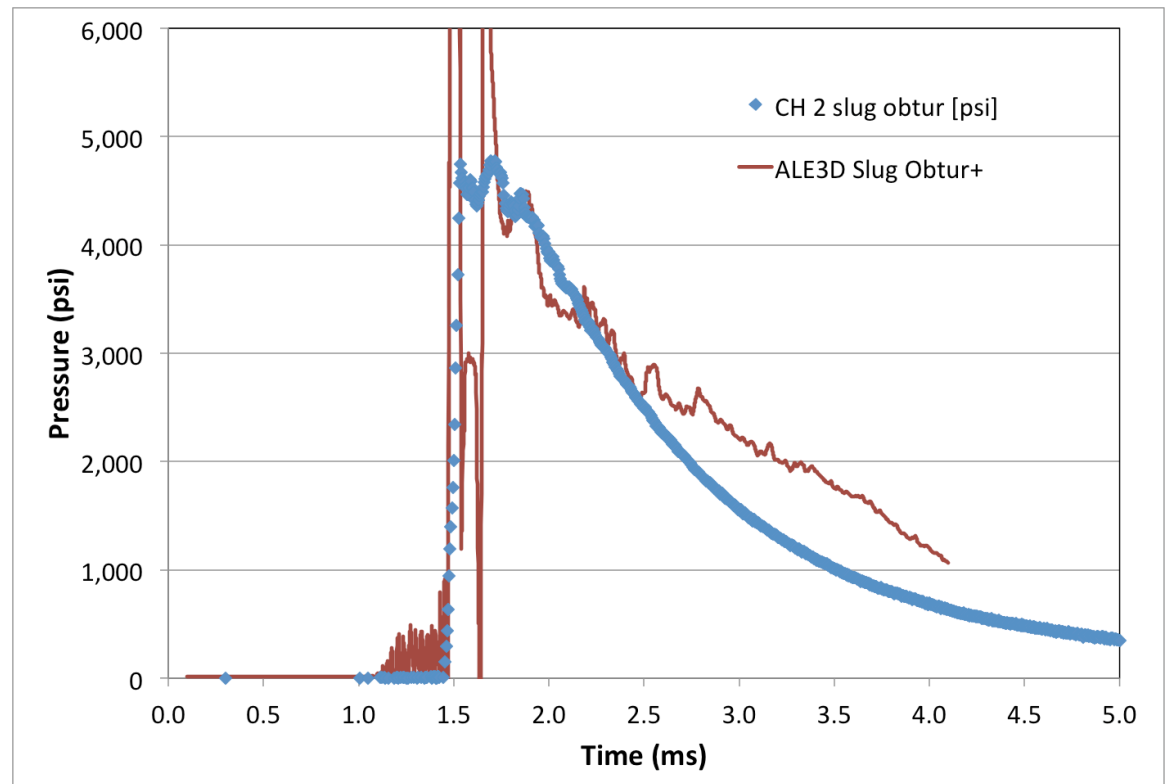
Obturator
[gage 2] experiment and simulation

- **Simulation peak and pulsewidth compare favorably with experimental data**
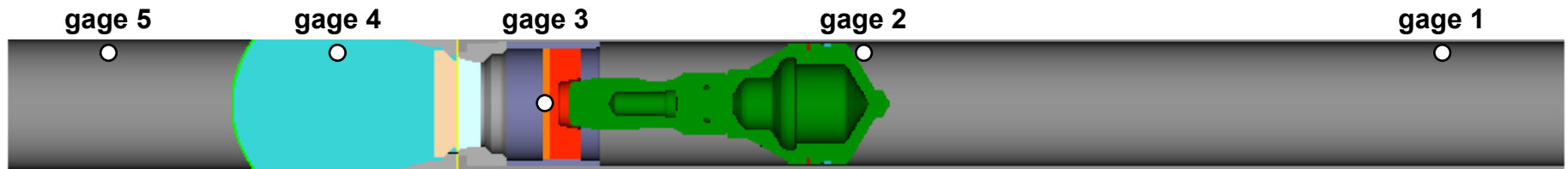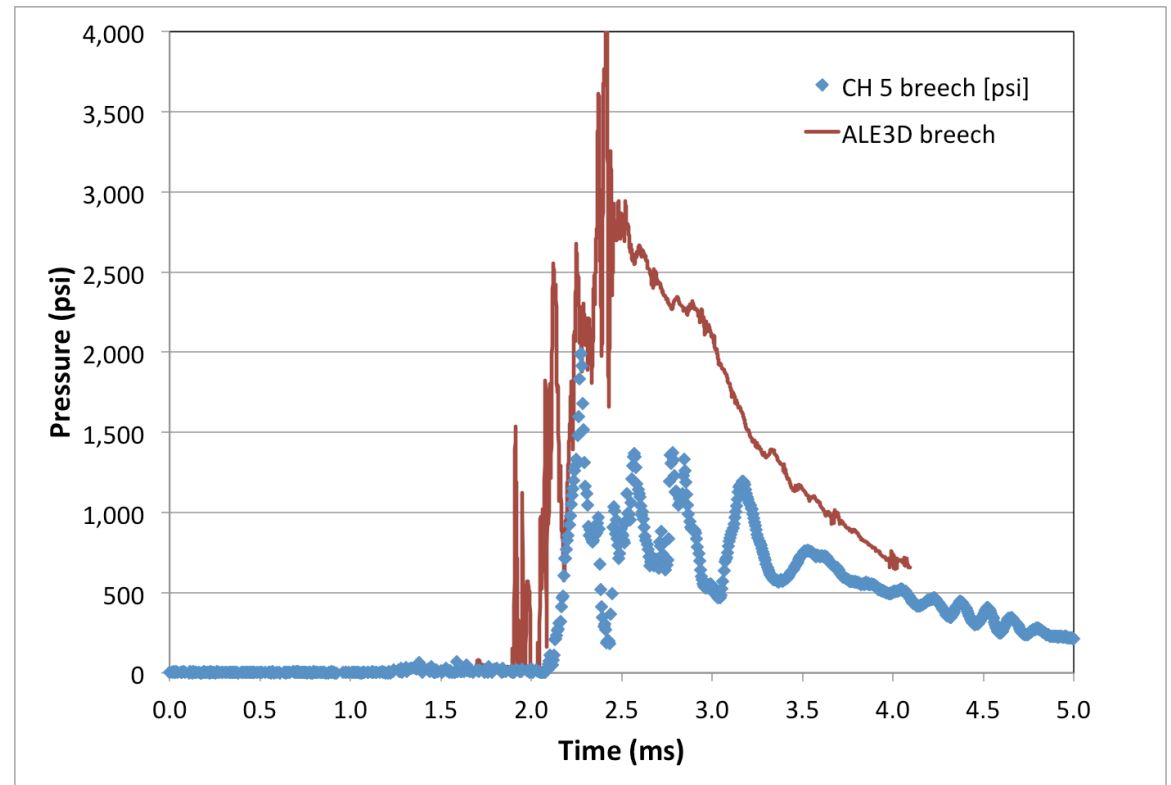
Breech
# [gage 5] experiment and simulation

- **Simulation peak pressure is too high**

- **Differences are probably due to details of front burst disk failure, which are beyond the scope of this project**

- **Consequently, we expect overpredictions at external blast overpressure gages**

gage 5   gage 4   gage 3   gage 2   gage 1

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Projectile speed [deliverable 2 of 2] experiment and simulation

- **Simulated exit velocity (~200m/s) compares favorably to ~180m/s experimental velocity**
    - experimental time-dependent projectile velocity not measured
    - experimental projectile exit velocity estimated from data
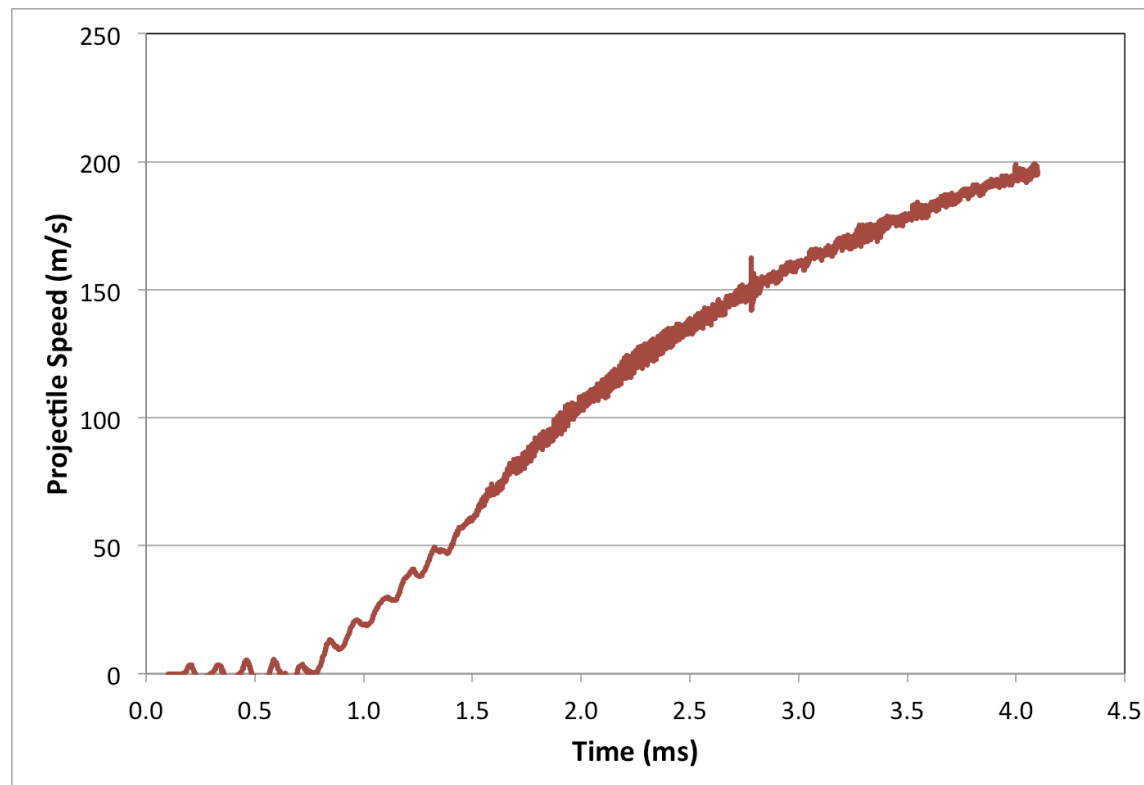
Summary

- **Simulated projectile speed and propellant chamber pressure agree sufficiently well with data to demonstrate the viability of using ALE3D to simulate the AT4-CS**

- **Detailed spatial and temporal modeling of the burst disk failure will be required to accurately model the countermass response and subsequent overpressures at Soldier locations around the AT4-CS**